Development of a Next Generation Platform and Instrumentation for Continuous Ocean Observations (PICO)

Christian Meinig
NOAA Pacific Marine Environmental Laboratory, Seattle WA

1. PROJECT SUMMARY

This continuation proposal requests funds to advance the state of NOAA's open ocean observation systems with the development of an easy to deploy and low cost mooring system which make use of new and commercially available sensors and instrumentation and which addresses issues of improved data return rates in areas prone to vandal induced data losses and reducing costs of high quality ocean observations. This effort is motivated by the need to develop a mooring & instrumentation system to replace and significantly improve upon the performance of existing ATLAS moorings used in NOAA's contribution to tropical moored buoy arrays in support of climate research and forecasting. A candidate system presently under development at PMEL is the Platform and Instrumentation for Continuous ocean Observations (PICO) mooring. A web site containing comprehensive information on the system under development can be found at http://www.pmel.noaa.gov/pico/.

2. ACCOMPLISHMENTS

From FY '08 Work Statement:

a. Build, test and deploy a complete PICO mooring with Prawler in local waters and off-shore.

Results:

Two PICO deployments were completed during this fiscal year, both of them successful and encouraging that our concept of a low-cost self deployed mooring with integrated ocean profiler (Prawler) is viable. The first test remarkably showed that even in protected water of Puget Sound in 200m the Prawler was still able to crawl in wind chop condition, completing 484 profiles and 16,250 meter during the 8 days test.

During a test deployment of two system in ~3000m south of Oahu, two PICO mooring system were deployed with surface MET measurements and Prawlers. During this ~40day test one Prawler (Figure 2) climbed 370km and telemetered temperature, pressure and engineering data in realtime via an inductive modem to the PICO surface buoy (Figure 1). Remarkably, the system average 30

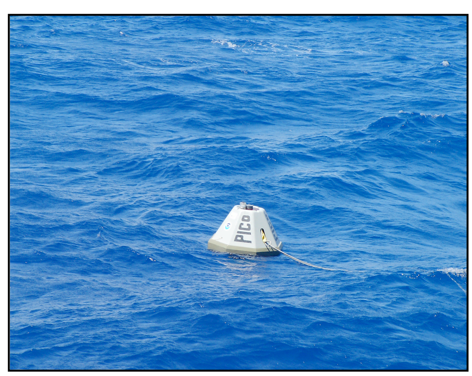


Figure 1. Hawaii Deployment 2008.

profiles per day to a depth of 350m using the heave energy from the surface buoy. Sensors and communication systems were powered by lithium batteries which determine the endurance of this first ocean deployment. We are encouraged by these results and plan on building the next generation Prawlers with increased endurance and climate quality CTD sensors.

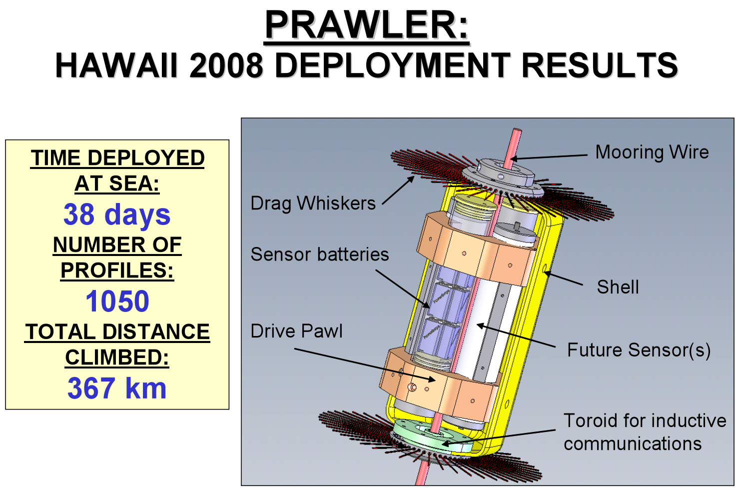


Figure 2. Prawler Configuration.

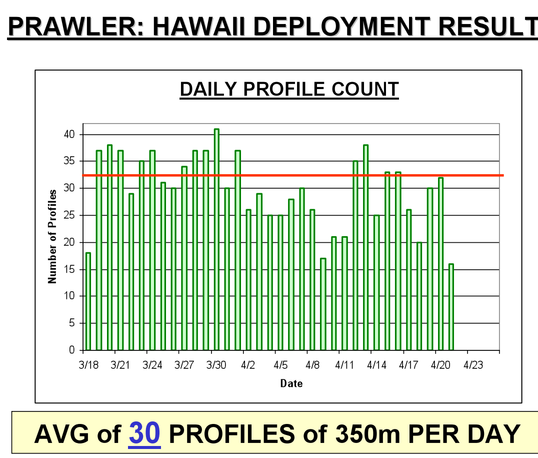


Figure 3. Profile Histogram.

b. Validate field data and correlate with WHOI cable software model results, with goal of 4 year, low-cost surface mooring endurance in tropical waters.

Results:

A detailed study was completed on various PICO mooring using WHOI cable software. The effects, on the PICO mooring's dynamic responses, from the addition of a profiler, appear to be largely dependant upon the vertical location (depth) of the profiler. Fixing the profiler at a depth of 325m consistently yields the most severe results, and this location should be used for future mooring modeling. The profiler's effects on static tension and mooring catenary can be considered to be negligible. The influences of profiler depth on the vertical movement of the mooring remain inconclusive.
Surprisingly, the addition of a weighted line section only has a moderate effect on the PICO mooring's catenary and line slope between 325m and 650m (at most 8%, assume the model has a "built-in" +-5% error). The addition of the weighted section has no beneficiary effect on the tension spread, but it does have a pronounced effect on the static tension at the buoy. Under calm current conditions and choppy seas the additional weight reduces the PICO buoy's tendency towards shock loading by greatly increasing the mean tension, while only slightly increasing the tension spread. Based on these results, it is recommended that the weighted line section be retained within the PICO mooring design.

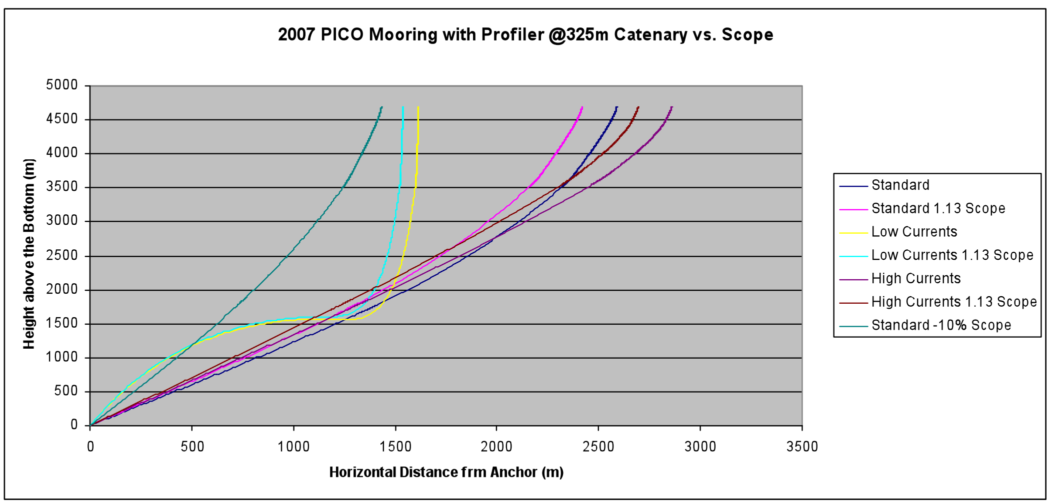


Figure 4. WHOI Software Mooring simulations.

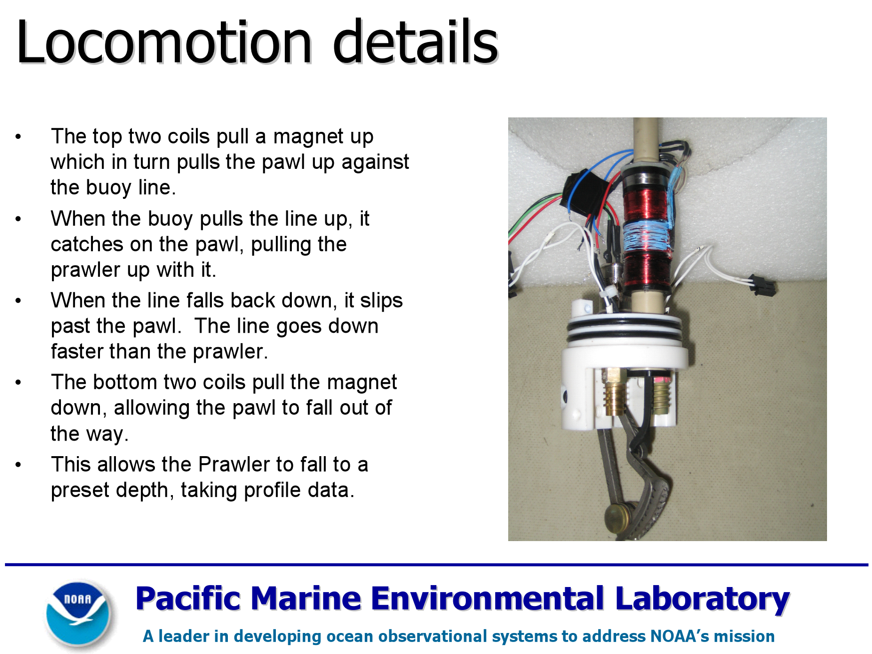
c. Design and evaluate upper terminations for ease of assembly, while meeting endurance goals.

Results:

The upper termination on the PICO mooring is the most complex design challenge of the mooring. A novel termination was designed, manufactured and tested in PMEL's Dynamic Line Testing machine then ultimately deployed on the two full ocean test moorings. One termination failed after 90 days while the other performed very well with minor signs of wear. Lessons learned will be incorporated in future designs and deployments.

d. Evaluate the design of the Prawler wave driven crawler mechanism. Determine endurance limits and evaluate alternative.

Two Prawlers were built, tested and deployed in Puget Sound and in 3200m south of Honolulu, Hawaii. We are encouraged by the results of our 38 day test deployment, in which on Prawler crawled over 367km. Upon recovery, the mechanism was 100% functional and was completely free of any bio-fouling or corrosion. The 2nd Prawler's communication system failed after a few days of testing, but the failure was unrelated to the Prawler wave driven mechanism (Figure). We are extremely encouraged by these results and plan on incorporating this mechanism in the next generation Prawler that we are proposing to build in FY'09.



e. Evaluate energy harvesting techniques and equipment for the PICO surface buoy and Prawler. Measure accelerations on Prawler to determine available energy for electrical conversion, build prototypes.

A PRAWLER as configured in Figure 1 was outfitted with a bi-axial accelerometer and place on a mooring line that was attached to a rotating armature on the R/V SP HAYES. The speed of the armature was set to match the data collected during the PICO Hawaiian deployment. The preliminary data analysis for available energy to convert to electrical power is not encouraging and in FY'09 we hope to explore alternative energy harvesting techniques on the PRAWLER.

f. Develop and test electronic circuit boards and systems for energy harvesting in the Prawler.

Test electronics A/D boards and computer were developed and outfitted as part of the SP HAYES testing in section e. All system performed very well, although the results of those tests will lead us in a different direction.

g. In addition to the PICO mooring hardware development described above we will continue to evaluate the Vaisala WTX510 for tropical moored buoys. Tests include:

a. Wind tunnel evaluation and calibration of the Vaisala WTX510 wind sensor.

b. Rain gage evaluation compared to standard ATLAS sensor at Seattle facility.

c. Atmospheric Temperature and relative humidity sensor calibration in PMEL lab.

Results:

The Vaisala WTX 510 sensor was evaluated by PMEL staff using standardized sensors for wind, rain and ATRH. Wind tunnel test were encouraging and compared well with our standard Gill Windsonic sensors. The RH sensors were calibrated in the chamber at 55-95% humidity in 10% increased steps and the Vaisala appears to be reading ~2% lower than standard ATLAS RH Rotronic Sensors. The Vaisala rain gauge is currently being evaluated relative to standard ATLAS rain gauges and testing is not yet complete. Currently a repackaging design is underway to include compass and Iridium telemetry options for the Vaisala WTX512, so that at sea testing can be conducted.